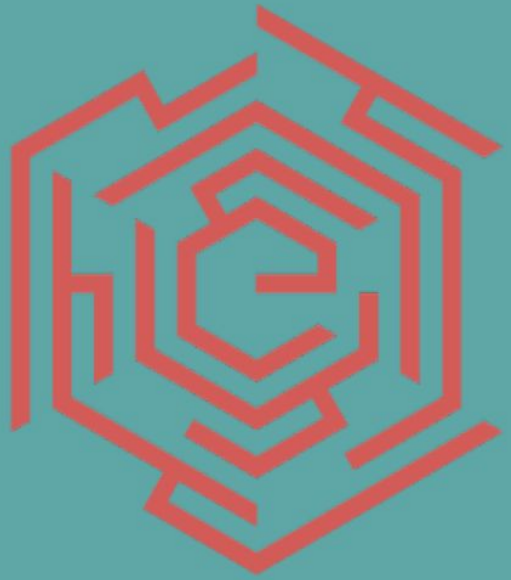
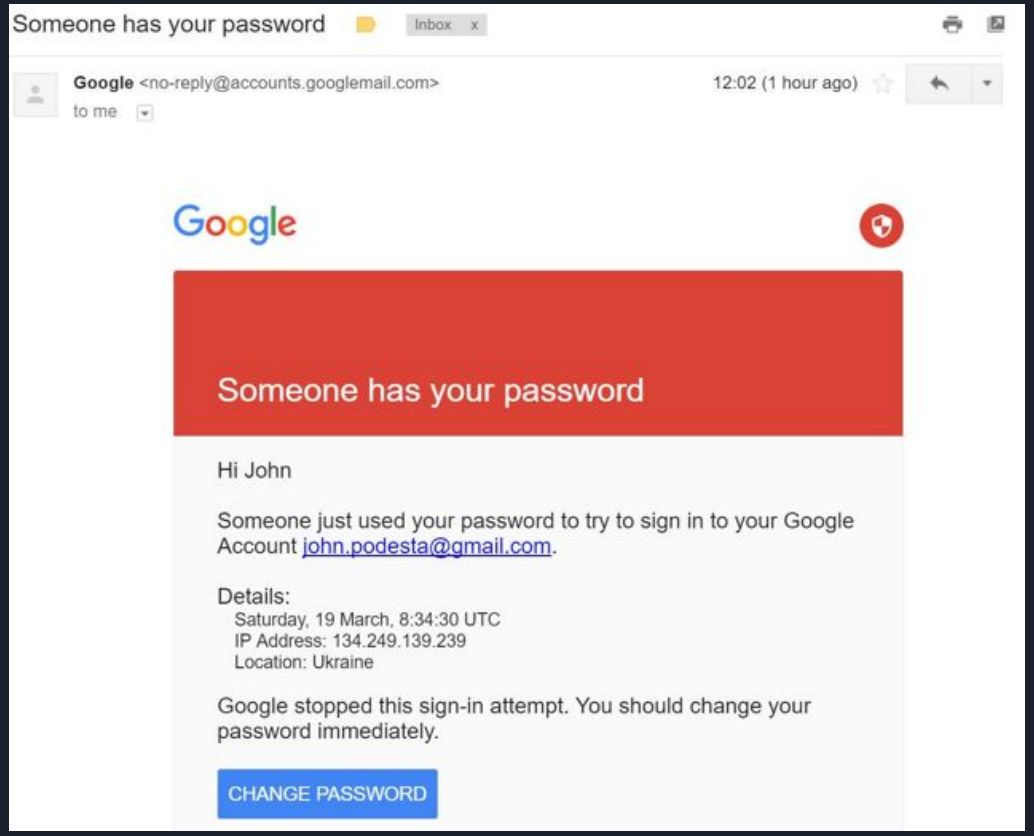


ENIGMA

Quantifying Memory Unsafety and Reactions to It

Alex Gaynor, Fish in a Barrel

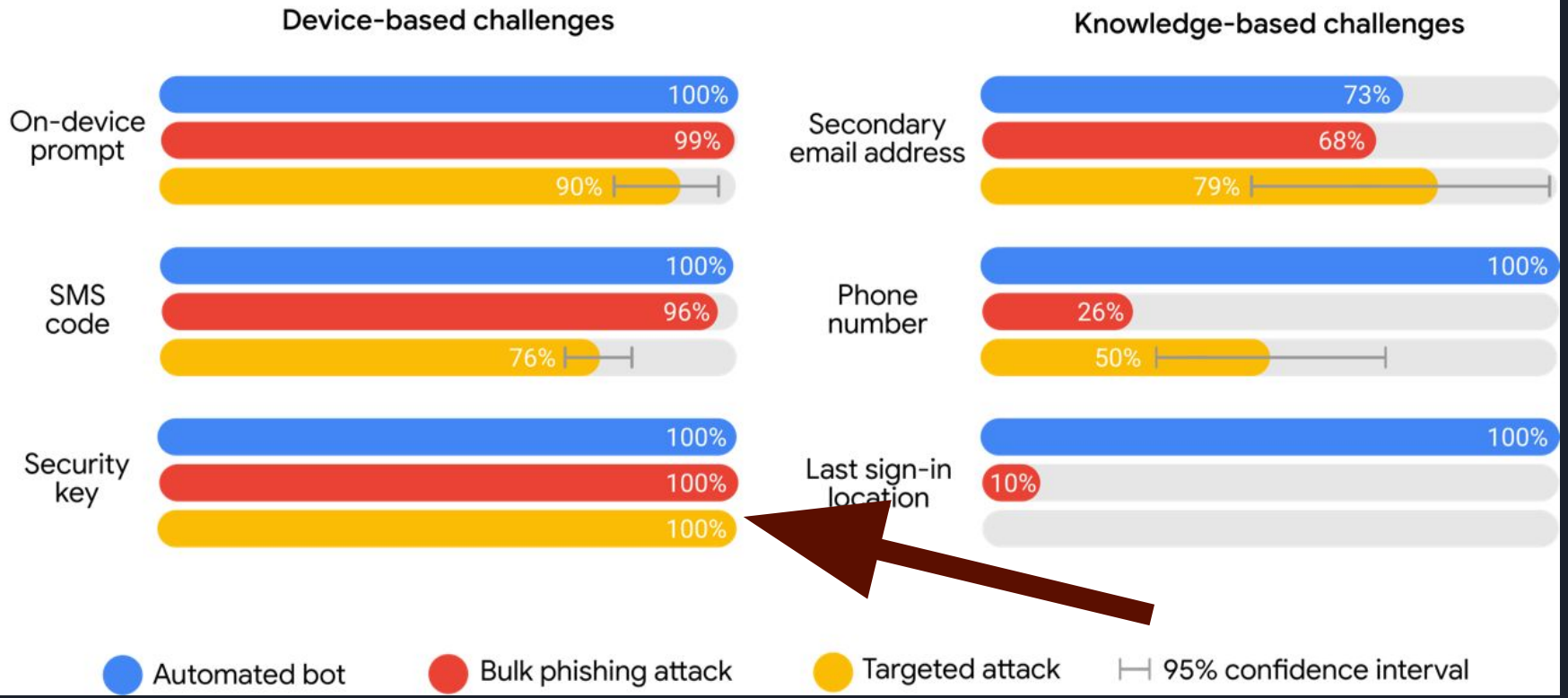
Fish in a Barrel, not a real company



John Podesta, 2016

Security keys

Account takeover prevention rates, by challenge type



Memory Unsafety

Properties of memory unsafety

- Spatial:
  - Buffer overflow (heap or stack, read or write)
- Temporal:
  - Use-after-free
  - Use of uninitialized memory
  - Wild pointer dereference
- Type confusion

Languages

Memory safe:

- Rust
- Swift
- Python
- Java
- Go
- etc.

Memory unsafe:

- C
- C++
- Assembly

Case studies

- iOS 0-day (and n-day) exploits used against the Uighurs
- iOS and Android n-day exploits used against Tibetans
- iOS 0-day exploits used against Ahmed Mansoor
- WhatsApp 0-day exploit, with varied targets
- WannaCry
- HeartBleed

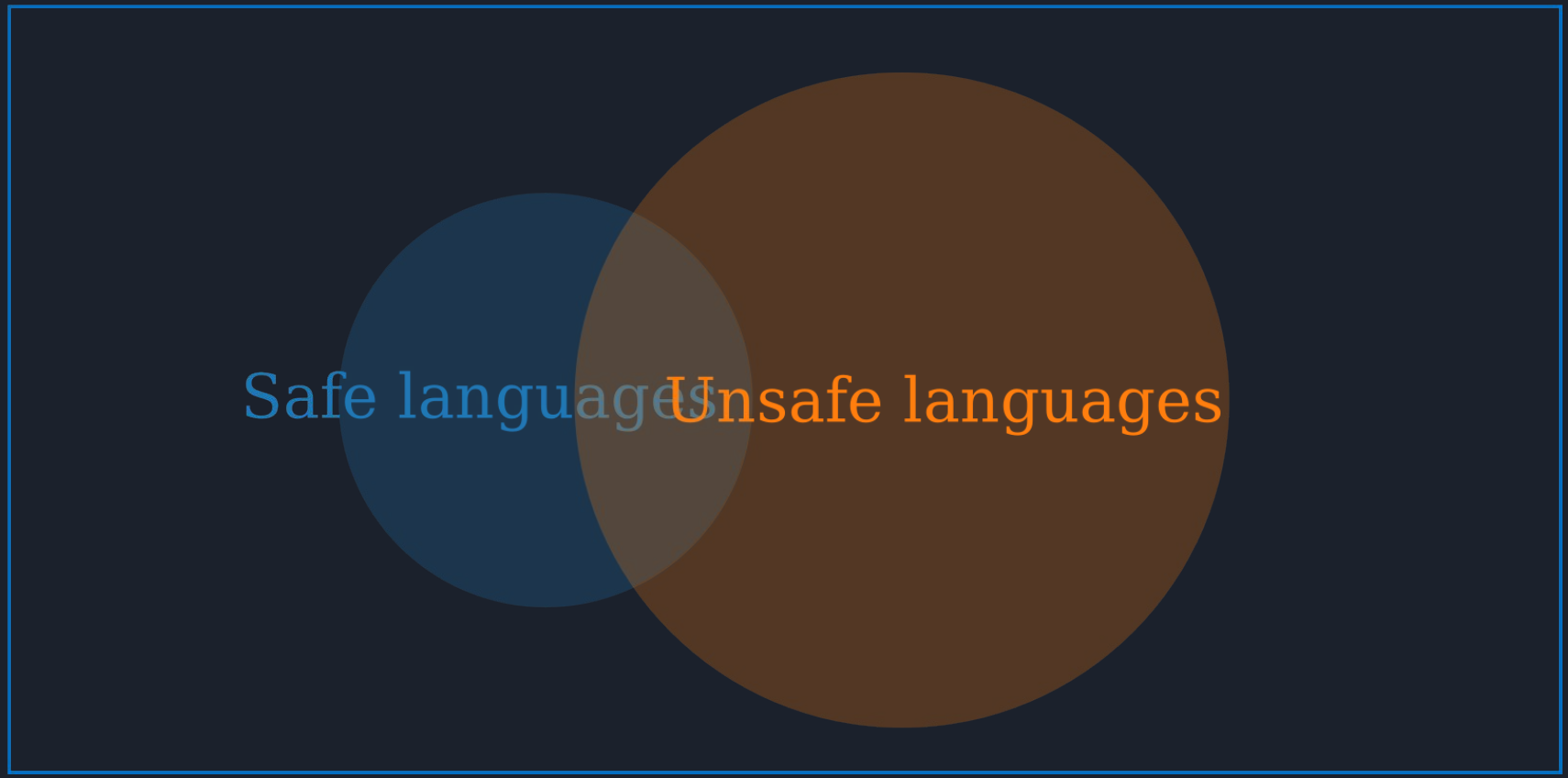
The stages of grief

Denial Symptoms:

“Programming in memory unsafe languages does not cause an increased rate of vulnerabilities.”

Denial: Data

- **Chrome**: 70% of high/critical vulnerabilities are memory unsafety
- **Firefox**: 72% of vulnerabilities in 2019 are memory unsafety
- **0days**: 81% of in the wild 0days (P0 dataset) are memory unsafey
- **Microsoft**: 70% of all MSRC tracked vulnerabilities are memory unsafety
- **Ubuntu**: 65% of kernel CVEs in USNs in a 6-month sample are memory unsafety
- **Android**: More than 65% of high/critical vulnerabilities are memory unsafety
- **macOS**: 71.5% of Mojave CVEs are due to memory unsafety



The vulnerability venn diagram

Anger symptoms:

“Yes, code in memory unsafe languages can have bugs. But if you were a better programmer, you wouldn’t have this problem.”

Anger: Complex systems

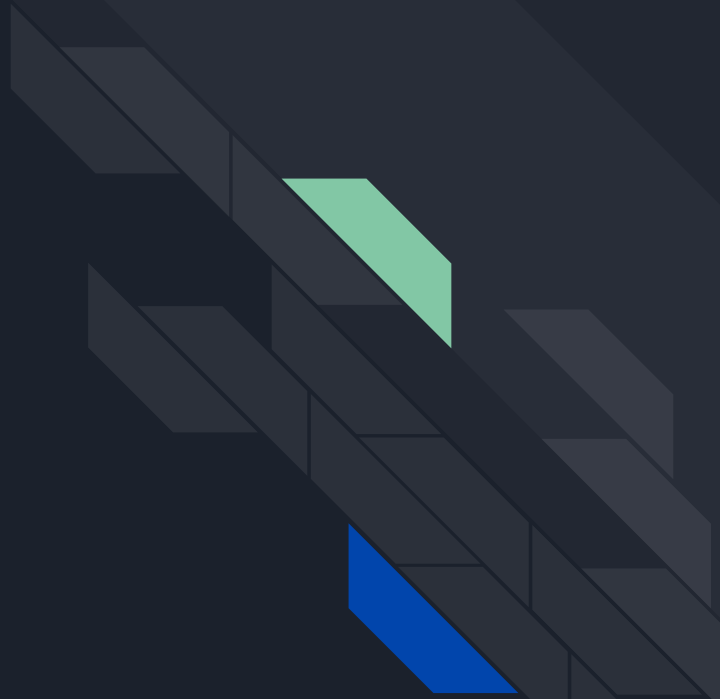
How Complex Systems Fail

(Being a Short Treatise on the Nature of Failure; How Failure is Evaluated; How Failure is Attributed to Proximate Cause; and the Resulting New Understanding of Patient Safety)

-- https://how.complexsystems.fail/

Bargaining symptoms:

“Ok, yes, memory unsafety is a problem. But surely we can address it with static analysis and fuzzing and sandboxing and mitigations and red-teaming.”



Bargaining: Response

- Chrome: Tens of thousands of fuzzing cores
- iOS: Every single app is sandboxed
- Windows: Extensive exploit mitigations, including KCFG
- Chrome: Aggressive multi-process sandboxed design
- All: Millions of dollars spent on bug bounties

Depression symptoms:

“Memory unsafety is a problem… but oh my god we have a trillion lines of C/C++, we can never rewrite all of it, everything is hopeless.”

Depression: Work smarter, not harder

- Identify high leverage places
  - Code that runs with high privileges
  - Code that acts as a key part of a security guarantee
  - Code that has a large user-accessible attack surface

Acceptance symptoms:

Asking how, not if.

A call to action

- Build a coalition who recognizes the gravity of this problem
- Find a memory safe language that's a good fit for your domain
- Stop the bleeding: make it possible for new code bases in your organization to be memory safe
- Find your highest leverage attack surfaces in existing memory unsafe code and get to work!
- Use language as a factor when assessing the security of projects

Proof that incremental migrations are possible

- Python Cryptographic Authority
- Rust-For-Linux
-
- Firefox
- Librsvg

Your project can be next!

Fin

Questions?

https://alexgaynor.net

Citations and references

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